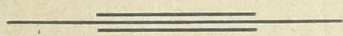


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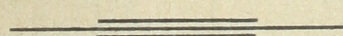
Pamphlet No. V.

RUSTLESS IRON AND STEEL.

THE BOWER-BARFF AND WELLS' PROCESSES.



The Bower-Barff Rustless Iron Company.



OFFICES:
BANK OF COMMERCE BUILDING,
Nassau and Cedar Streets,
NEW YORK CITY.

1893.



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—THE—

POWER-BARFF RUSTLESS IRON COMPANY.

Officers.

D. M. THOMAS, - - PRESIDENT.
ROSSITER W. RAYMOND, TREASURER.
GEO. W. MAYNARD, - SECRETARY.

Directors.

S. V. WHITE, Banker, - - New York City.
PETER COOPER HEWITT,
Cooper, Hewitt & Company, New York.
CHARLES L. MERRITT,
Jones Hollow-Ware Company, Baltimore, Md.
WILLIAM T. WELLS,
The Wells Rustless Iron Company, Little Ferry, N. J.
GEO. W. MAYNARD,
Mining and Metallurgical Engineer, New York.
ROSSITER W. RAYMOND,
Cooper, Hewitt & Company, New York.
D. M. THOMAS,
Secretary National Association of Stove Manufacturers,
New York.

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RUSTLESS IRON.

Rustless iron, as the name implies, is iron without rust.

In a strictly technical sense there is no such thing, except in the laboratory, as rust is oxidation, and all ordinary iron is more or less oxidized.

Our processes are intended to oxidize, and thereby protect iron from further change.

In a commercial sense "Rustless Iron" means iron which will not form the common red or sesquioxide when exposed to the action of moisture.

It is a well-known fact that the magnetic or black oxide of iron is unchangeable in the presence of the atmosphere, and is not affected by the action of salt or fresh water. Hence it will not rust or change under ordinary conditions.

History of Rustless Iron.

For very many years it has been the desire of chemists and all interested in the finer lines of iron-work to artificially produce the magnetic or black oxide of iron.

In the early history of chemistry it was found that superheated steam produced this oxide when brought in contact with red hot iron; the familiar gun-barrel experiment, as set forth in the text books, being one of the earliest recorded instances of its being produced in the laboratory.

It was many years before it was accomplished in anything like a commercially successful manner, and this was done by Professor Frederick S. Barff, of Kilburn, England, who first published an account of his process in 1876, and also read a paper describing his work before the Society of Arts in London.

It was found that the Barff process could not be made a commercial success on work of large dimensions, chiefly because of the extremely high cost and also on account of the difficulty in obtaining uniformity in results.

Messrs. George and Anthony Bower, of St. Neots, England, encouraged by Professor Barff's partial success, continued experiments which Mr. George Bower had abandoned previously, and, having purchased the Barff rights, took out a series of patents covering their inventions. By combining their improvements with those of Professor Barff's there was formed the well-known Bower-Barff process. Mr. George Bower read a very interesting paper before the Iron and Steel Institute of Great Britain describing their work.

Shortly after, Mr. George W. Maynard formed the Bower-Barff Rustless Iron Company of New York and acquired all rights in the Bower-Barff patents for the United States.

Messrs. Poulson & Eger, proprietors of the Hecla Architectural Iron Works of Brooklyn, E. D., were the first to take out a license and construct furnaces. Their first furnace was built under the immediate supervision of Mr. George W. Maynard, who, in connection with Mr. W. H. Winslow, a member of the above firm, made some valuable improvements in the manipulation of the processes. Messrs. Poulson & Eger have treated a very large variety of highly ornamental work.

The next furnace constructed was by Mr. W. T. Wells, at Little Ferry, N. J.

After using the Bower-Barff processess for about a year Mr. Wells succeeded in improving the methods then in use, his attention being drawn to the peculiar action of the gases on some heavy iron-work which he heated in his furnace

with the simple intention of bending. After careful study of this action and extended experiments, he made an important chemical discovery, viz., that red-hot iron in the presence of mingled steam and carbonic oxide gas would take on the magnetic or black oxide coating without the intermediate formation of sesquioxide. This is embodied in his patents of 1888, and is the foundation of the Wells process.

Properties of Rustless Iron.

The magnetic oxide coating is very hard. It withstands the wear due to friction, but is injured by blows of the hammer and rough usage. Wherever from this cause the coating is chipped, the iron rusts, though the rust remains localized; it very rarely spreads or raises the coating, as is commonly the case with paint or electro deposits.

The protection of the iron being due to a conversion of the surface to a magnetic oxide, and not to anything penetrating the metal (which would weaken it), it follows that any manipulation that would injure or destroy the continuity of the surface of the iron must necessarily prove destructive of the coating. In riveting, for example, the oxide in the immediate neighborhood of the rivet holes suffers; similarly, in driving nails through sheet-iron roofing, the oxide is chipped at the holes; in fitting "rustless" gas and steam pipe it is injured by the bite of the wrench and vise unless special tools are furnished; in shearing, it scales along the edge of the metal, and in flanging or bending sheet iron the coating on the line of the bend is cracked. The limit of elasticity of the oxide is practically the same as that of the iron; it adheres firmly to the metal under tensile and compressive strains until this limit has been reached, and no further.

A piece of "rustless" iron can be heated on a kitchen range and then plunged into cold water without the least scaling or other change, while coverings of paint, tin, galvanizing and enamel suffer very much under such action. For this reason "rustless" hollow-ware is more readily cleaned than even enameled ware; the latter must be allowed to cool after use, and the remains of food in it become dried and congealed and stick to the utensil, necessitating considerable scraping and involving danger of injuring the enamel.

Magnetic oxide withstands the action of many brines, alkalies, sulphureted gases and weak, organic acids, but it is gradually dissolved by sulphuric and hydrochloric and other powerful acids. The corroding action of these acids, however, is considerably retarded on "rustless" iron, and hence such iron has been successfully used in chemical works where it was exposed to strong acid fumes.

Treated articles have been exposed for years to seawater and to the most varied atmospheric conditions without the slightest deterioration. Cast-iron urinals, used for three years in the yards of an iron works, have remained perfectly free from corrosion.

The processes are being studied carefully and exhaustively, and it is hoped and believed that in a short time still greater improvements in the coating will result.

The Rustless Iron Processes.

These have for their object the protection of iron and steel from rusting, and also the production of a highly ornamental and lasting finish. This result is obtained by the conversion of the surface of the metal into magnetic oxide of iron. The oxide is well known in its natural state as magnetic iron ore, which has withstood without deter-

ioration or change centuries of exposure to the atmosphere and to fresh and salt water.

Oxidized iron has been in the market in Europe and this country for a number of years, and is so well known and is so much appreciated by those who have used it that it has ceased to be a matter of experiment.

No foreign material such as paint or alloy is applied to the metal, so that the surface is perfectly pure.

The Bower-Barff method accomplishes the formation of magnetic oxide upon iron articles by subjecting them successively to the action of highly heated air and carbonic oxide gas derived from coal fires. The hot air converts the metallic surface into red oxide of iron, which is reduced to the black or magnetic oxide by the gas, and the process is then completed by the action of superheated steam. This steam also produces the black oxide and penetrates to parts which might have been passed over by the gas. It also toughens the coating.

The Wells method is an improvement on the preceding and affords a simpler and still more effective operation. The articles to be treated, being charged into a chamber at a low heat, are raised to a proper temperature and then subjected to the action of mingled steam and carbonic oxide gas, by which the black or magnetic oxide coating is formed in *one operation* in a thorough and complete manner.

Surfaces of iron and steel treated by the processes present a pleasing blue-gray or blue-black color, and preserve the sharp outline of artistic and well-executed designs; while, if the articles are polished before treatment, the result of the oxidation is a lustrous, ebony black finish, which is highly prized for its beautiful effect.

The processes have now a record of nearly ten years in the United States, so that it is no longer necessary to refer

to European practice for evidence of their value. In furnace construction and other particulars marked improvements have been made.

Furnaces have already been established in the States of Pennsylvania, New Jersey, New York, Connecticut, Massachusetts, Illinois and Kentucky, and others will shortly be erected.

The process is applicable to all forms of cast, malleable and wrought iron and steel, where the surfaces are not subjected to severe friction, nor injured by subsequent manipulation. It is gradually supplanting the expensive and unsatisfactory and sometimes poisonous galvanizing, and for ordinary culinary utensils should take the place of tinning and enameling.

The demand for cast and wrought iron pipe protected by this treatment for plumbing, drainage, gas, salt works, steam-heating, irrigating, and wherever it is desirable to protect pipes from rusting, is one of the most significant indications of the recognition of the value of the process.

Its application to architectural iron-work, both exterior and interior, is not by any means confined to the preservation of the iron or prevention of rust, but is likewise used for beautifying the work, and a new impetus has thus been given to the use of iron for decorative and architectural work. It is now no longer necessary to disfigure costly artistic work by paint or other so-called anti-rust coatings. We are largely indebted to the taste and intelligence of architects for the revival of the artistic use of iron in many of the finest buildings erected during the past four years.

Among the prominent buildings in which the iron-work has been, in whole or in part, treated by the process, as required by the architect's specifications, are the following:

Work furnished by the HECLA IRON WORKS, Brooklyn,
E. D., N. Y.

Produce Exchange.....	New York City.
Standard Oil Building.....	" "
Cotton Exchange.....	" "
The Western Union Buildings in Broad Street and Twenty-third Street.....	" "
Park Bank.....	" "
Brooks Building.....	" "
Navarro Apartment Houses.....	" "
Dakota Apartment Houses	" "
Columbia College Library Building.....	" "
Mortimer Building.....	" "
Young Men's Christian Association Building, Bowery Branch.....	" "
Schermerhorn Building.....	" "
Galatin Bank.....	" "
Patterson Building.....	" "
Central Trust Company Building.....	" "
Equitable Building.....	" "
Market and Fulton Bank	" "
Yosemite Apartment House.....	" "
Solomon Loeb Building.....	" "
The Winthrop Apartment House	" "
Bank of America	" "
Corbin Building.....	" "
Brown Brothers Building.....	" "
Union Trust Company.....	" "
Continental National Bank.....	" "
World Building	" "
Chelsea Apartment House	" "
Plaza Hotel	" "
Public School No. 87.....	" "
Mechanics' Bank	" "
Consolidated Stock and Petroleum Exchange	" "
New York Life Insurance Building.....	Kansas City, Mo.
New York Life Insurance Building.....	Omaha, Neb.

Cutter Letter Boxes, manufactured by the Cutter Manufacturing Co	Rochester, N. Y.
Hundreds of elevator cars in all parts of the country.	
Brooklyn Tern inus of the East River Bridge.....	Brooklyn, N. Y.
The Principal Public School Buildings of Brooklyn.....	" "
Brooklyn Elevated Railroad Stations.....	" "
Quincy Apartment House.....	" "
Clarendon Hotel.....	" "
Lullwater Bridge, Prospect Park.....	" "
Sears Building.....	Boston, Mass.
Museum of Fine Arts	" "
American Bell Telephone Building.....	" "
Henry Hilton's Residence	Saratoga, N. Y.
Imperial Fire Insurance Building.....	Philadelphia, Pa.
Union and Planters' Bank.....	Memphis, Tenn.
Hussey Building	Pittsburgh, Pa.
Westinghouse Building	" "
Marine National Bank.....	" "
St. Nicholas Law Building	" "
Hudson County National Bank.....	Jersey City, N. J.
Stewart Cathedral.....	Garden City, L. I.
Bank of the Republic.....	Philadelphia, Pa.
Home Insurance Building	Chicago.
Phoenix Building.....	"
Union League Club Building.....	"
Adams Express Building.....	"
State Capitol.....	Springfield, Ill.
Northwestern Life Insurance Building.....	Milwaukee, Wis.
Senate Chamber.....	Topeka, Kan.
Sun Building.....	Washington, D. C.

Work furnished and erected by the Winslow Brothers Company, of Chicago.

Marshall Field Building.....	Chicago.
Ely Building.....	"
McCormick Theological Seminary.....	"
Northern Hotel.....	"

Auditorium Building.....	Chicago.
Pontiac Building.....	"
Chicago Herald Building.....	"
Heisen Building.....	"
A. J. Stone Building.....	"
Woman's Temple Building.....	"
The Fair.....	"
Monadnock Building.....	"
Kearsarge Building.....	"
Title and Trust Building.....	"
Tacoma Building.....	"
Chamber of Commerce Building.....	"
Manhattan Building.....	"
Caxton Building.....	"
Monon Building.....	"
Venetian Building.....	"
Leiter Building.....	"
Administration Building, World's Fair.....	"
Gallery of Fine Arts, " ".....	"
Phoenix Building.....	"
Chronicle Building.....	San Francisco.
Mills Building.....	"
Crocker Building.....	"
Academy of Sciences.....	"
German National Bank.....	"
Hickox Building.....	Cleveland.
Mather Building.....	"
Society for Savings Building.....	"
Lillibridge Bank.....	"
Western Reserve Bank.....	"
Wade Bank Building.....	"
Kansas City Court House.....	Kansas City.
Coates House.....	"
Midland Hotel.....	"
Mining Exchange Building.....	Denver, Col.
Equitable Building.....	" "
Blickensderfer Building.....	" "
Knox, Currier & Walker McPhee Building.....	" "

Broadway Theatre	Denver, Col.
People's Bank Building	" "
West Denver High School	" "
Ernest & Cranmer Building	" "
Colorado Club	" "
Boston Block	" "
Evans Building	" "
Wainwright Building	St. Louis.
U. S. Court House and P. O.	Galveston, Tex.
U. S. Court House and P. O.	Findlay, Ohio.
U. S. Court House and P. O.	Hannibal, Mo.
U. S. Court House and P. O.	Fairfield, Iowa.
U. S. Court House and P. O.	Circleville, Ohio.
Bailey Building	Seattle.
Horton Building	"
Equitable Building	Atlanta, Ga.
Equitable Building	Des Moines, Ia.
Sibley, Lindsay & Curr	Rochester, N. Y.
Utah Loan and Trust Building	Salt Lake.
Mechanics Building	Pueblo, Col.
Michigan Trust Building	Grand Rapids.
Pabst Building	Milwaukee, Wis.
Davidson Theatre	" "
Theatre	Guanojuato, Mex.
Endicott Building	St. Paul.
Metropolitan Opera House	"
Pioneer Press Building	"
Germania Bank Building	"
Merchants' National Bank	Tacoma, Wash.
Hackley Library	Muskegon.
Commerce Bank Building	Omaha, Neb.
Bee Building	" "
Lewis Block	Pittsburgh, Pa.
Morris Block	New Orleans, La.
Boston Block	Minneapolis, Minn.
Lumber Exchange Building	" "
Temple Court Building	" "
Lumber Exchange Building	" "

Globe Building	Minneapolis, Minn.
Public Library Building.....	" "
U. S. Custom House and P. O.....	Columbus, O.
Globe Publishing Company Building.....	St. Paul, Minn.
Nelson & Weller Building.....	Kansas City, Mo.
Cullen Building.....	Salt Lake City, Utah
Bank Building.....	Los Angeles, Cal.
Phoenix Bank Building.....	Bay City, Mich.

The Snead & Company Iron Works, of Louisville, Ky., have furnished the Bower-Barffed iron-work for the following buildings:

New Congressional Library Building	Washington, D. C.
Ashland Block.....	Chicago.
Masonic Temple.....	"
Marshall Field Building.....	"
Athletic Club.....	"
Louisville Medical College.....	Louisville, Ky.

PROSPECTUS.

THE BOWER-BARFF RUSTLESS IRON COMPANY is the sole owner of the processes for making iron rustless by the magnetic processes. The Company receives applications for licenses to use its franchises and furnishes working drawings and estimates for the erection of special furnaces in which the treatment is carried out.

The fullest facilities are afforded for testing and studying the treatment, and detailed information is gladly tendered to parties desiring to become acquainted with the working of the processes. Parties erecting furnaces will be fully instructed in their management by the Company's engineers.

Samples of "*rustless*" cast and wrought iron are on exhibition at the Company's offices, and will be sent on application. In particular cases the Company treats at small cost iron-work as samples, which must, however, invariably have express or freight charges *prepaid*.

Notes on the Bower-Barff Processes.

The following brief review of the processes, in their leading features and most recent developments, may serve to show how readily they can be adapted through a very extended range of iron manufactures.

MODE OF TREATMENT.

The conversion of the surface of metallic iron into magnetic oxide of iron is carried out in a furnace. The articles to be treated, whether large or small, are loaded upon an iron drag and charged into a fire-brick chamber, known as the oxidizing chamber of the furnace. Gas producers, which constitute a part of the furnace structure, generate carbonic oxide gas from a thick bed of coal upon the producer grates; this gas is burned by an admixture of air in a combustion flue beneath the oxidizing chamber, and either the burning gases, or the hot products of combustion, according as the gas and air valves are regulated, enter through ports into the chamber, heating the charge and then passing through exit ports to the chimney. After the goods have been raised by this means to the desired temperature, which may vary from an incipient red to a cherry heat, depending on the nature of the work, the treatment of the charge is begun.

During the period of oxidation the connection with the gas producers is almost entirely cut off by a damper, and air raised to a high temperature by passing through the hot combustion flue above mentioned, enters the chamber and oxidizes the iron, converting its surface into the red oxide of iron (Fe_2O_3). After about forty minutes of this treatment the admission of air to the furnace is stopped and the producer gases are allowed to pass for twenty minutes through the chamber without any admixture whatever.

The chemical action of these gases upon the iron results in a change or reduction of the superficial coating of red oxide of iron into the black, or magnetic, oxide (Fe_3O_4). The operations are repeated a number of times; highly superheated steam is then introduced into the oxidizing chamber where a slight plenum, not exceeding 1 to 2 inches of water-pressure, is maintained for a period of two to six hours. The steam from a half-inch pipe more than suffices for all the requirements.

At the end of the treatment the charge is withdrawn and the furnace is then ready for treating another lot of work.

The Wells Process.

When the work has all been raised to the proper temperature, it is then subjected to the action of mingled steam and carbonic oxide gas, which produces at one operation the black or magnetic or rustless oxide of iron. After a sufficient exposure to the mixture the charge is withdrawn and allowed to cool. Careful laboratory experiments show that iron heated in a closed wrought-iron muffle and subjected to the action of steam alone will have a somewhat crystalline coating, and that there will be more or less sesquioxide formed. But when iron is heated in the same muffle and subjected to the action of the mingled steam and carbonic oxide gas, the result is an even, perfect and more tenacious coating of magnetic or black oxide. In practice the manipulation is carried on as follows:

The charge of iron or steel articles is placed in a heating chamber and there gradually heated during a period of some hours. It is important not to heat any part of the charge so as to blister it, and yet every part must be raised to the heat required by the process. The inventor prefers

to use the gas made in the well-known Siemens' Producer for heating the charge, and to admit air in limited quantities into the chamber along with the gas coming from the producers. During this operation the dampers are open, permitting the escape of the products of combustion into the chimney. The heating must be gradual, so that the charge will be raised in temperature evenly and equally and all blistering avoided. The surface of the charge by this gradual heating is apt to become somewhat oxidized, both to red and black oxide, but the effect is irregular and patchy where it does appear at all, and is not of any general importance in the result. The next and final step in the process is to turn on a mixture of steam and carbonic oxide gas, and then the chimney damper is closed. In this atmosphere of steam and carbonic oxide the charge is left for some five hours, more or less. The heat of the charge at the beginning of the operation is a dull-red, and air should be excluded as far as possible. The steam need be under little or no pressure, and may or may not be superheated before introducing into the chamber. This final step of the process is the essential one, in which is produced the desired result of black or magnetic oxide.

The following letter is from the well-known chemists, Doctors Wells and Vulté, of the School of Mines, Columbia College, New York.

NEW YORK, March 8, 1893.

THE BOWER-BARFF RUSTLESS IRON COMPANY,
New York City, N. Y.

Gentlemen:

It gives us pleasure to say that in the year 1889, at the request of THE WELLS RUSTLESS IRON COMPANY, we made a series of laboratory experiments, in order to ascertain if the process of oxidizing iron, which is known as the "Wells Process," did or did not embody an entirely new fact in chemistry. After most thorough research and

experiment we found that the claim of a new discovery was fully confirmed by the results of our work.

We found that surfaces of iron (or steel) exposed to the action of mingled steam and carbonic oxide gas would be changed into the black or magnetic oxide at one operation and without the formation of any sesquioxide (red oxide).

In none of the many works on chemistry consulted by us were we able to find any mention of such a chemical reaction taking place or the possibility of such reaction.

We therefore declare it to be an entirely new discovery.

Very truly yours,

JAS. S. C. WELLS, Ph.D., F. C. S.,
Analytical and Consulting Chemist.

H. T. VULTÉ, Ph.D., F. C. S.,
Analytical and Consulting Chemist.

Referring to the engravings, Figs. 1 and 2 are vertical longitudinal sections of the furnace, which is built of masonry in the ordinary way, about 5 feet high, 25 feet long and 6 feet wide. Figs. 3 and 4 are horizontal sections of the furnace, while Figs. 5 and 6 are transverse vertical sections. The section in Fig. 1 is made on the line *ff* (Fig. 3), and on the line *ee* (Fig. 5). Fig. 2 is a section on the line *gg* (Fig. 5). Fig. 3 is a section on the line *hh* (Fig. 1) and on the line *aa* (Fig. 2). Fig. 5 is a section on the line *dd* of Fig. 2. Fig. 6 is a section on the line *cc* (Fig. 2). Referring now to the special parts of the furnace, *V* is the gas valve; *A* (Fig. 2) is an air valve; *G* is a gas flue; *H* is a steam valve; *C* combustion chamber; *O* (Fig. 2) an opening into the port chamber *I* (Fig. 6); *h h h* (Figs. 1, 4, 5 and 6) portholes; *T* is the main heating chamber, with an escape at *E* (Fig. 3); *D* is a chimney damper (Fig. 1) and *F* in the same figure is the chimney flue; *P* (Fig. 2) is a checker-work in the combustion chamber; *sss* are sightholes in the back of heating chamber; *ll* are curtains of masonry.

When the articles are to be treated for the production of a rustless oxide on the surface, they are placed in the heating chamber *T*, through the door *B* (Fig. 2). The charge is gradually heated up through a period of, say, ten to twelve hours, according to the size, by means of gas from a Siemens producer, admitted through the flue *G* by opening the valve *V*. A small quantity of air is also admitted for the purpose of combustion by opening the valve at *A*, Fig. 2, during which operation the damper *D*, Fig. 1, is opened, permitting the escape of the products of combustion to the chimney. The gas, entering through *V*, mingles with the air passing through *A* at the extremity of the curtain, and is further mixed with the air by the checker-work *P* in the combustion chamber. The burning gas, passing through *O*, enters the port chamber *I* (Figs. 3, 5, 6), from which it passes up through the ports *h* around, through and over the charge in *T*, and thence through the ports *h* into the escape flue *E* to the chimney flue *F*. When the charge has been heated to a dull red, the valve *A*, Fig. 2, is closed, and steam is admitted through the valve *H*, the damper *D* being closed. For five hours the charge is submitted to the action of the mingled steam and carbonic oxide gas, the air being excluded as far as possible.

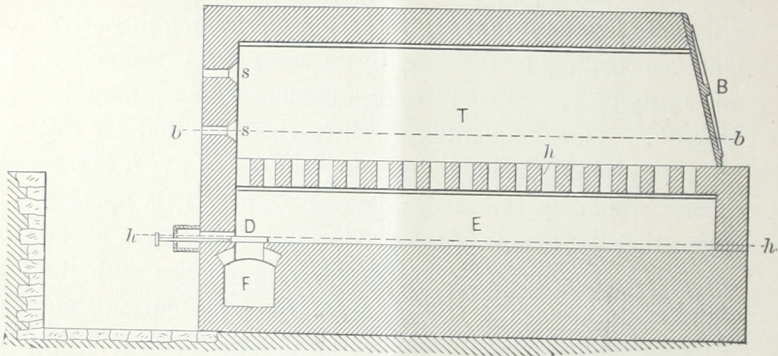


FIG. 1.—VERTICAL LONGITUDINAL SECTIONS OF FURNACE.

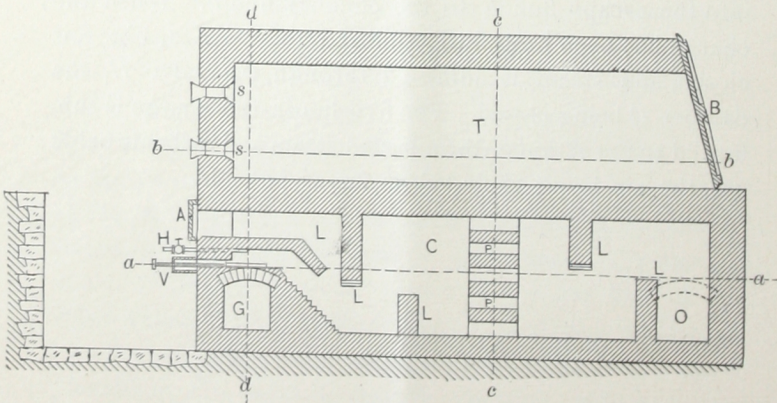
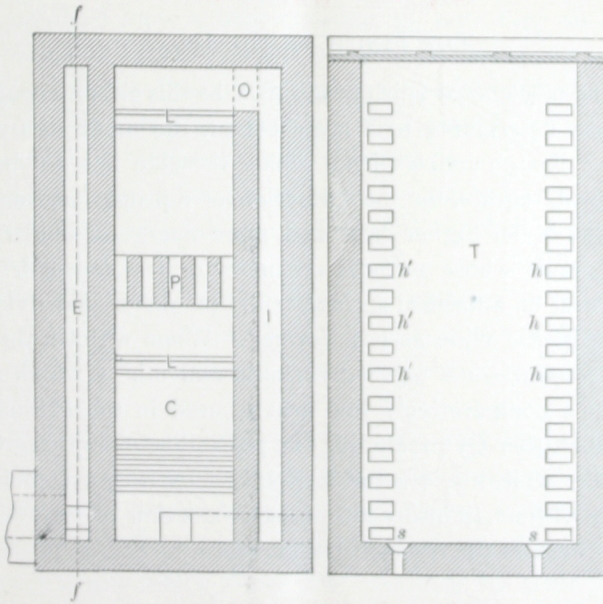
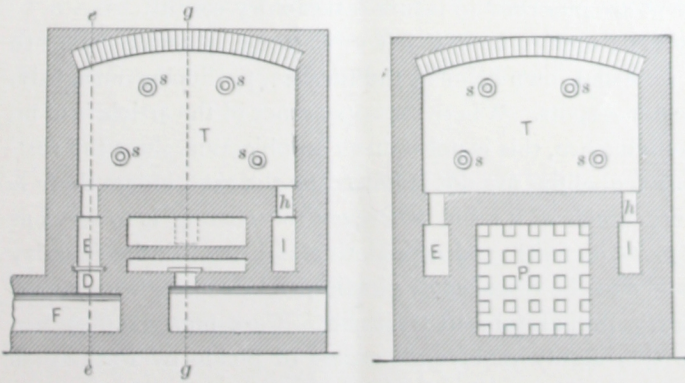


FIG. 2.—VERTICAL LONGITUDINAL SECTIONS OF FURNACE.



FIGS. 3 AND 4.—HORIZONTAL SECTIONS OF FURNACE.



FIGS. 5 AND 6.—TRANSVERSE VERTICAL SECTIONS OF FURNACE.

Special Mention.

THE FINISH OF THE IRON.

The mechanical finish of the iron, be this either wrought or cast, determines, to a large extent, the mode of treatment. Rough articles, from which the skin has not been removed, require, for the formation of a proper coating in a given time, higher heat and more energetic oxidation than goods whose surfaces are more or less finished. A high heat on a finished surface tends to blister and detach the magnetic oxide as it is formed. When articles, therefore, present some finished surfaces and others which are rough, a comparatively low heat is used in the oxidizing chamber, thereby precluding the possibility of injuring the surface, while the treatment is continued for a sufficient length of time, to insure a thorough oxidation of the rough parts, even at the reduced temperature.

PREPARATION OF THE IRON.

Certain points in the preparation of the iron for treatment are observed to insure satisfactory results.

(1) Foundry sand, if left on castings, generally bakes to a reddish-brown color in the furnace, producing unsightly, rust-like spots. Where the appearance of the article is of no consequence, this is not in itself an objection, since the rust-proof qualities are not impaired by the sand unless there is very much of it; but wherever the coating is to serve as a mode of finish, and no painting is intended, the foundry sand must be removed by pickling and cleansing with a steel brush, preparatory to treatment. Care must be observed to thoroughly remove all excess of pickle by washing in hot water after withdrawing the articles from the pickling vat.

(2) In treating wrought iron a handsome appearance of the oxidized ware is only obtained by removing all forge or rolling-mill scale before treatment. Pickling and brushing accomplish this, but for a large class of ordinary work the expense of this preparation is not incurred, and only the loose scale is brushed off before treatment.

(3) Articles which are to have a polished surface must be polished to the full extent desired *before* treatment in the furnace.

(4) Blowholes or other defects in castings must not be plugged with lead, for the action of lead in the furnace is decidedly injurious to the iron. Only brass or iron plugs can be used.

(5) The iron generally undergoes a very slight permanent expansion in the furnace, but this is not sufficient to require any special fitting, except in cases of very tight, accurate fit. In columns and stair stringers for architectural work, in which slight errors multiply by repetition, a scant measurement of $\frac{1}{24}$ inch per foot has been found to allow sufficiently for permanent expansion.

(6) All drilling of holes, truing of faces, etc., must be done *before* treatment, to save the magnetic oxide coating from the injury which subsequent fitting would cause.

Mechanical Tests With "Rustless Iron."

The following tests show conclusively that iron is not weakened by the BOWER-BARFF treatment; the action in the oxidizing furnace is incidentally one of annealing, and this compensates, and in many cases of thin casting more than compensates, for the very thin layer of metal which is oxidized and loses its strength in the treatment.

REPORT OF TESTS BY SIR JOSEPH WHITWORTH, OF LONDON.

Metal No. 433.

BEFORE TREATMENT.		AFTER TREATMENT.	
Pressure in tons.	Alteration.	Pressure in tons.	Alteration.
15	Nil.	..	..
17	"	..	..
18	"	18	Nil.
19	"	19	"
20	"	20	"
21	"	21	.0008
22	.0002	22	.0022
23	.0008	..	..

Metal No. 603.

BEFORE TREATMENT.		AFTER TREATMENT.	
Pressure in tons.	Alteration.	Pressure in tons.	Alteration.
15	Nil.	..	..
17	"	..	..
18	"	18	Nil.
19	"	19	"
20	"	20	"
21	.0002	21	.0007
22	.0009	22	.0023

REPORT OF TESTS BY PROFESSOR BACH, OF THE STUTTGART POLYTECHNIC INSTITUTE.

These tests were made on forty-eight 19.9 millimeter ($\frac{3}{4}$ inch) round bars, the tabulated results being averages of six tests each.

Wrought Iron.

		Tensile strength.		Elongation p. c.		Contraction of area p. c.
				p. 100 mm.	p. 200 mm.	
Not treated	{	lbs. p. sq. in....	50,733	20.7	17.5	27.2
		k. p. sq. cm....	3,567			
Treated 3 hours	{	lbs. p. sq. in....	48,362	21.8	18.6	29.6
		k. p. sq. cm....	3,400			
" 5 "	{	lbs. p. sq. in....	49,756	21.2	19.6	31.2
		k. p. sq. cm....	3,498			
" 5 "	{	lbs. p. sq. in....	49,557	21.8	19.0	31.8
		k. p. sq. cm....	3,485			

Cast Iron.

		Tensile Strength.
Not treated	{ lbs. p. sq. in	28,022
	{ k. p. sq. cm	1,970
Treated 4 hours	{ lbs. p. sq. in	26,826
	{ k. p. sq. cm	1,886
Treated 6 hours	{ lbs. p. sq. in	27,524
	{ k. p. sq. cm	1,935
Treated 6 hours	{ lbs. p. sq. in	28,050
	{ k. p. sq. cm	1,872

According to these figures the effect of the treatment of iron by the BOWER-BARFF process is in the main limited to the action of annealing. So far as the effect of strains upon the coating of magnetic oxide is concerned, it was noted that small particles scaled off from wrought iron when the tensile strength reached 2,012 kilograms, or 28,618 pounds per square inch, and that in the case of cast iron it did not come off, even when strained to the point of rupture.

Tests of Bower-Barffed Iron.

MR. HENRY M. HOWE, the eminent metallurgist, whose work on "THE METALLURGY OF STEEL" has been recognized at home and abroad as the standard authority, has carried out a series of experiments for the purpose of determining the relative value of the various protective coatings of iron. These results are given in the Second Edition of Vol. I of his "Metallurgy of Steel," on page 372, under the title of "ANTI-RUST COATINGS."

"Finding no data as to the relative protection against rusting afforded by different protective coatings, Mr. R. W. Lodge and the author have carried out a series of experiments with exposures lasting from ten months to a year, with both thin sheet wrought iron and plates of cast iron, under four different conditions of exposure and with six protective coatings, specimens of the same irons without protective coating being exposed simultaneously. A fifth series of

plates was immersed in sea water, but, in spite of very considerable precautions to prevent their being carried away by the water or by men, they cannot be found.

LOSS OF WEIGHT OF WROUGHT AND CAST IRON WITH DIFFERENT PROTECTIVE COATINGS AND UNDER DIFFERENT CONDITIONS, IN POUNDS PER SQUARE FOOT OF SURFACE PER ANNUM.

Wrought-Iron Sheets (No. 23 gauge, black).

PROTECTIVE COATINGS.	Exposed to the Weather Inland.		Immersed in—		Average.
	Canada.	New York State.	Fresh Water.	Sewage.	
Bower-Barffed.....	gain, .0	gain, .000.3	.006.7	.003.6	.002.5
Tinned.....	gain, .002.0	.000.1	.010.4	.007.1	.006.2
Nickel-Plated.....	.0	.000.5	.050.4	.003.1	.013.5
Galvanized.....	gain, .000.4		.045.9	.080.5	.042.0
Barffed.....	.001.0	.003.1	.083.9	.117.0	.051.2
Black—i. e., unprotected....	.001.3	.022.6	.137.0	.169.0	.082.5
Copper-Plated.....	.000.2	.005.0	.179.0	.182.0	.091.6
Average.....	.000.02	.005.1	.074.6	.080.3	.040

Cast-Iron Plates.

PROTECTIVE COATINGS.	Exposed to the Weather Inland.		Immersed in—		Average.
	Canada.	New York State.	Fresh Water.	Sewage.	
Bower-Barffed.....	gain, .004.0	gain, .003.1	gain, .005.5	.001.4	gain, .002.8
" " and Paraffined.....	.000.6	.001.9	.000.2	.008.4	.002.8
Galvanized.....	.0	.0	.049.1	.061.0	.027.5
Tinned.....		gain, .003.1	.065.5	.061.0	.041.1
Nickel-Plated.....	gain, .003.4	.002.5	.131.7	.083.3	.053.5
Copper-Plated.....	" .004.0	.005.0	.150.8	.119.2	.067.8
Black—i. e., unprotected....	" .006.3	.012.0	.148.3	.272.4	.106.6
Average.....	gain, .002.9	.002.1	.007.2	.086.7	.041

" A single sheet of No. 23-gauge refined wrought iron was cut into plates 6" x 12", and others 6" x 6". Of the 6" x 12" pieces some were exposed without treatment of any kind, the scale left on; others were tinned; still others were galvanized by the Rhode Island Tool Company. Of the

6" x 6" plates some were Bower-Barffed by the Yale and Towne Company, others were Barffed by the Pratt and Cady Company, still others were nickel-plated and copper-plated in each case after pickling. The cast-iron pieces were skin-bearing plates, 4" x 3.5" x 0.187", presented by Professor Geo. W. Maynard. These were subsequently given the coatings indicated, their original skin being retained in all cases.

"One set of the pieces thus prepared was exposed on the roof of a dwelling house in the Eastern Townships of the Province of Quebec, Canada, by Mr. E. C. Hale, of Sherbrook, Canada; a second was similarly exposed in a village in Rensselaer County, New York State; a third was immersed in the Chestnut Hill (Boston) Reservoir, by Mr. Desmond Fitzgerald, of Boston; a fourth was immersed in the Boston main sewer, near the pumping station, by Mr. H. H. Carter, of Boston.

"In each of the conditions of exposure the wrought-iron pieces were in one open wooden crate, the cast-iron ones in a second, the corners of the pieces (and in the case of the 6" x 12" wrought-iron pieces a small space in the middle of the long sides) alone being in contact with the crate; and that care was taken that the specimens should not touch each other or any other metallic substance. Though exposed nearly a year, including autumn, winter and spring, at the end of the experiments the gummed labels still adhered to twelve out of the twenty-six specimens exposed in Canada and in New York.

"*In brief*, the BOWER-BARFFED pieces lost much less, and the copper-plated and naked pieces decidedly more, than the others. The cast iron lost about as much as the wrought iron; the loss was about the same in fresh water and in sewage, and slightly less in Canada than in New York. Comparing the different conditions of exposure, immersion, of course, greatly accelerates rusting. Thus, in ten out of the fourteen sets of cases the pieces immersed in fresh water lost at least twenty times as much as those exposed to the weather in New York. The loss is slightly but fairly constantly greater in New York than in Canada, which helps to explain the celebrated brightness of the tinned roofs of the Canadian churches. The loss in sewage is

slightly greater than in fresh water, but far from constantly, for in seven out of the fourteen cases the loss in fresh water excels or about equals that in sewage, a result most unlooked for and wholly at variance with Mallet's results with fresh water. It, however, recalls Mallet's results with sea water, in which sewage, on the whole, retarded the corrosion of skin-bearing cast iron. Comparing the different protective coatings the BOWER-BARFFED *pieces win easily, undergoing no loss in five out of the eight cases*, and, with the single exception of the nickel-plated wrought iron in sewage, losing less than half as much as any of the other irons in the three other cases. The copper-plated and uncoated iron lose most heavily, the copper-plating, on the whole, accelerating the rusting, especially in the case of the wrought-iron sheets. The tinned pieces come in as a good second in case of wrought iron, the galvanized as a bad second in case of cast iron. As between nickel-plating and galvanizing in the case of wrought iron, and as between nickel-plating and tinning in case of cast iron, it is not easy to decide whether the apparent difference is not due to individual peculiarities of the pieces tested."

Testimonials.

We have a large number of letters and testimonials, both American and European, extending over the period since the introduction of the processes. Their volume has become so great that it is not practicable to publish them. These testimonials may be seen at the company's office or will be furnished on application. The following indicate sufficiently the general character of the testimonials.

Bower-Barff Rustless Iron Pipes for Plumbing.

For permission to reprint the following extract from the series of articles on "The Water Supply of Buildings,"

we are indebted to the author, Mr. J. P. PUTNAM, and the Editors of the *American Architect and Building News*.

MATERIAL AND GENERAL ARRANGEMENT OF THE SUPPLY PIPES.

The material now in general use for direct, as well as tank, supply is lead. From its cheapness and facility of working, it has long been the favorite material with plumbers, and for tank distribution pipes it has no serious objection.

For conveying drinking and cooking water, however, sanitary considerations sometimes preclude the use of unprotected lead when the water is of such a character as to act upon it. The nature of the water in this respect in any locality must be obtained from competent local authorities. Other defects in lead for supply as well as for waste pipes are its softness and great weight, which attributes cause it to "sag" and "crawl" after being put in place. It has little toughness and no elasticity, and its use for supply pipes seems destined very soon to be superseded in a great measure by iron, as it already has been in the main waste-pipe system.

Protecting Lead Pipe.—A protective coating, more or less effectual, may be applied to lead pipes by filling them with a weak solution of phosphate of soda, which precipitates upon the inner surfaces an insoluble coating of phosphate of lead. Or sulphate of potassium or sodium may be used, forming a precipitate of sulphate of lead. These chemicals produce quickly the same effect of protection as would be produced slowly by the natural flow of hard water through the pipes.

Tin-Lined Lead Pipes.—Lead pipes may be protected more reliably by lining them with a stout coat of tin, the salts of which, formed by water, are also insoluble and harmless. The interior lining of tin should, however, be thick, and, in fact, a continuous and independent pipe forced into permanent contact with the lead by hydraulic pressure. This pipe is considerably more expensive than lead pipe, and requires greater care in putting together than the latter, to avoid injuring the lining.

Tinned brass ferrules or couplings should always be used in jointing. These are furnished by the manufacturers with the pipe.

A prejudice has arisen against the use of this pipe on account of the poor quality of much that has been sold. The coating of tin has been too thin, and the jointing improperly done. The result of this is that the lining easily breaks, melts or wears off in places, leaving the lead exposed, and the two metals then produce, in the presence of

water, a galvanic action, which is supposed to seriously hasten the destruction of the pipe.

Pure Block Tin Pipes are perfectly safe from a sanitary point of view, but they are difficult to handle and repair. These drawbacks and the great cost are sufficient to limit the use of block tin to very rare occasions.

Brass and Copper Pipes are easily attacked by water, and the resultant salts are poisonous. Hence, if used for the conveyance of drinking water, they should be tinned on the inside. Nevertheless, the tin coating, as usually applied, has no appreciable thickness, and will not long protect the brass or copper from corrosion. They are, therefore, not to be recommended for conveying drinking or cooking water in any case. Brass is still very largely used for hot-water lavatory service, in preference to lead, as it is better able to stand the alternations of heat and cold to which this service subjects them. Lead in this case would soon be destroyed by this action.

Wrought iron for supply pipes has, besides its sanitary advantage, that of great strength, toughness, cheapness, and facility of jointing. Although instances have often been cited of unprotected wrought-iron service pipes lasting for from ten to twenty years, we know that it requires some permanent coating to render it in all cases safe against destruction and clogging. Water coming through iron pipes is uninjured for drinking, and indeed is sometimes improved.

An enormous amount of time and ingenuity has been spent in the search for a permanent protective coating for iron which should be at once cheap and reliable; but until within the last few years with no very encouraging results. Galvanizing or zinc coating was, when first introduced, thought to have solved the problem, but a great many kinds of water are found to decompose the zinc and yield with it poisonous salts; moreover, imperfections in the coating, difficult to avoid, cause a destruction of the iron much more rapidly than would be the case were no coating applied, so that this means of protection is now regarded as altogether unsatisfactory.

Tin-coated iron has never met with success, on account of the difficulty of making the tin adhere to the rough inner surface of the pipe. Tin-lined iron pipe, however, in which an independent continuous pipe of tin is inserted within the iron, the two being brought into close contact by hydraulic pressure, forms, if properly put together, a very good supply pipe. As with the tin-lined lead pipe, great care should be taken in jointing, and special tin-lined iron fittings furnished by the manufacturers should be used for all joints. This pipe, however, can

scarcely be classed as *coated* iron pipe. It is practically nothing more than a double pipe, of tin and iron, of which the outside receives no protection. The pipe is comparatively expensive, and, if not very accurately jointed, galvanic action assists natural corrosion and hastens destruction. It has never found great favor among plumbers, and is rarely used.

From glass-lined iron pipe much was expected when it was first introduced a few years ago, but it is difficult to cut with the ordinary tools used by plumbers, and, largely on this account, it has never become popular. This difficulty, together with its expense and the brittleness of the lining, have been considered so great that its use has for some time been practically abandoned.

Asphalted wrought-iron pipe has been much used, but cannot be considered as a permanent pipe. For hot-water conveyance it is not well suited, on account of the tendency of the hot water to destroy the coating.

Enameled iron pipe varies as much in character as in the variety of ways in which it is made. When new, the different kinds resemble each other so much that it would be impossible for the ordinary observer to distinguish between the good and the bad. With some the enameling consists of nothing more than a shiny, but perishable, coat of baking varnish. With others the pipe is coated with a thick, hard, glossy elastic enamel of great durability.

The Bower-Barff Process.—There is another protective treatment of iron totally different in character from any of the preceding, which appears to have met the problem before us in a most satisfactory manner. No foreign substance whatever is added to the iron, except oxygen, which converts its surface into a magnetic oxide. This coating has the remarkable power of effectually withstanding, apparently indefinitely, the corrosive action of air and water, hot or cold, fresh or salt, under most trying conditions.

The formation of the magnetic oxide is accomplished by subjecting the iron to the action of superheated steam in furnaces especially constructed for the purpose. The cost of treatment is very low, and, so far, the results have answered every expectation, and been eminently satisfactory. The pipe is put together like ordinary gas-piping, with screw joints, except that only oil need be used at the threads, instead of red and white lead. The oil soon becomes sufficiently hard to make a tight joint, and is free from the danger of poisoning the water.

We believe that this pipe is destined to supplant all others for the

conveyance of water. There are many places in plumbing, as we shall show, in which its use would save beyond all question, and would effect a great saving in the cost of the work.

Architects are very generally specifying for rustless iron pipe for plumbing in the best buildings of New York and other cities.

LOUISVILLE, KY., March 4, 1893.

GEO. W. MAYNARD, Esq., *Secretary*,
New York, N. Y.

Dear Sir:

In reply to your letter asking us regarding our success with our Bower-Barffing Furnace we should say, we have now been operating the furnace about eighteen months and are producing beautiful results in treating architectural iron-work, both cast and wrought.

Among the notable buildings where we have done Bower-Barffing in large quantities, we mention the New Library of Congress at Washington, D. C. the book stacks in which were made and treated by us. The library is the largest in the world.

The ornamental iron-work of the Ashland Block in Chicago is all Bower-Barffed, consisting of stairways, column casings, store fronts, elevator screens, etc.

The large Masonic Temple, a twenty-story building in Chicago, having fourteen elevators, the screens of which were made and Bower-Barffed by us.

We are now doing considerable Bower-Barffing for the new building for Marshall Field and the new Athletic Club in Chicago and the Louisville Medical College in this city.

Yours truly,

THE SNEAD & CO. IRON WORKS,
UDOLPHO SNEAD,
Vice-President.

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 SPECIAL SILVER MEDAL, AMERICAN INSTITUTE, NEW YORK, 1883.
 SILVER MEDAL, INTERNATIONAL HEALTH EXHIBITION, LONDON, 1884.
 SILVER MEDAL, INTERNATIONAL UNIVERSAL EXHIBITION, LONDON, 1884.
 SILVER MEDAL, SOCIETY OF ARTS, LONDON, 1876.
 BRONZE MEDAL, SYDNEY, 1880.
 BRONZE MEDAL, YORKSHIRE INDUSTRIAL EXHIBITION, 1879.
 BRONZE MEDAL, ROYAL CORNWALL POLYTECHNIC SOCIETY, 1879.
 SILVER AND BRONZE MEDALS, INTERNATIONAL EXHIBITION, LONDON,
 1884, FOR ENAMEL-WORK ON OXIDIZED IRON.
 BRONZE MEDAL, AMERICAN INSTITUTE, NEW YORK, 1884, FOR
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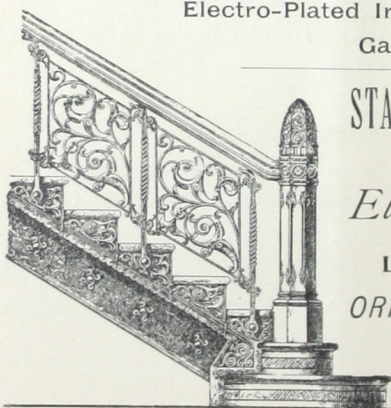
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